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*December* 4.—Nucleus seen at intervals between the breaks in the clouds. Three of the points dimly visible: the streak of light, which now alone forms the centre of the nucleus, resembles a string of luminous beads almost hidden by a luminous gaseous veil stretched over them. A decided change is going on in the nucleus, which does not seem to be decreasing much in brilliancy at present. The tail was tolerably bright for about 8° from the nucleus, when it became very faint, and the "shepherd's crook" was scarcely visible. It was about 2° in width, at a distance of 4° from the head.

*December* 5.—Comet fainter. Nucleus oval and granulous.

*December* 9.—Comet resembles an elliptical nebula condensed along its conjugate axis. I can no longer detect the points.

The comet was observed on every day that it was visible from September 13 to December 14, the telescope employed being a $9\frac{1}{2}$-inch silvered-glass Reflector by Calver.

*Grahamstown, Cape of Good Hope.*

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## *On the Magnifying Power of a Telescope.* By J. M. Schaeberle.

(*Communicated by W. H. M. Christie.*)

I have lately devised a very simple arrangement by means of which the magnifying power of a telescope can be determined with almost any desired degree of accuracy. The only apparatus required is a thin wooden arm about two feet in length, by three or four inches in width at one end, tapering to an inch or less at the other end, and pierced by two fine needles, one near each end of the arm. The needle near the wide end is driven into a table, or any horizontal surface, and serves as an axis about which the arm can be revolved. Directly over this axis the eyepiece is placed in such a position that a narrow slit not more than $\frac{1}{100}$ of an inch in width (formed by fastening two pieces of tin or paper over the opening in the cap which covers the eye-end of the ocular) shall be coincident with the prolongation of the axis of rotation. The optical axis of the eyepiece having been made horizontal, the observer, stationed behind a second but wider slit placed at a distance of several feet from the ocular, and on the same level with it, marks the two positions of the arm (by pricking holes into the table with the other needle) at which the diffused light, passing first through the eyepiece, then through the narrow slit towards the observer, is occulted by the diaphragm in the focus of the eyepiece. If $r$ denotes the distance between the needles, and $d$ the distance between the two prickings in the table, the angle A, subtended by a diameter of the diaphragm, as seen through the eye-end of the ocular, will be given by the equation

$$\sin \tfrac{1}{2} A = \frac{\tfrac{1}{2} d}{r}.$$

If $t$ denotes the time required for a star, near the meridian

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and having the small declination $\delta$, to cross a diameter of the diaphragm, the eyepiece being now attached to the telescope, the expression for the magnifying power P will evidently be

$$P = \frac{\tan \frac{1}{2} A}{\tan \frac{1}{2} (15 \, . \, t \cos \delta)}$$

essentially the formula given by Rev. W. Dawes in vol. xxiii. of the *Monthly Notices* of the Royal Astronomical Society. This ardent astronomer there gives a way for finding this angle directly, but for several reasons the results obtained by the method can only be regarded as rude approximations, and he evidently so considered them at the time, for in the same paper he concludes that probably a more accurate way for finding this angle would be to deduce it from the known magnifying power determined by other methods. Now, a comparison of the results obtained by the different methods with which I am familiar leads me to affirm that the most accurate procedure by far, for determining the magnifying power, involves the *direct measurement* of the angles subtended by the diaphragm (or any other plane figure placed in the common focal plane of the objective and eyepiece) as seen from the object and eye ends of the telescope.

An example showing the superiority of this method over the one most commonly given will best illustrate what has been claimed above. Let the effective diameter of the object-glass be 9 inches, and the actual magnifying power 300. The theoretical diameter of the image of the object-glass as formed by the eyepiece when it is placed in the stellar focus will be 0·03 inch. Now, the mean of a most careful series of measurements of the diameter of this image, called the bright spot, may easily be in error several thousandths of an inch: an error of only one one-thousandth of an inch would cause an error of ten diameters in the resulting magnifying power. If we suppose that a diameter of the diaphragm in the eyepiece subtends an angle of 6′ at the objective, we have the following figures:—

| Measured Diameter of Bright Spot. | Resulting Power. | Resulting Angle A. |
|---|---|---|
| in. | | ° ′ |
| 0·029 | 310 | 30 16·5 |
| 0·030 | 300 | 29 20·5 |
| 0·031 | 290 | 28 24·2 |

Now, granting that the mean of a series of *direct measures* of the angle A is in error one whole minute of arc, the resulting power will be in error only 0·18 of one diameter. In general, if $n$ represents the number of minutes of arc subtended at the objective by a diameter of the diaphragm in the stellar focus, and $x$ the number of minutes that the angle A is in error, the

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number of diameters or parts of a diameter that the resulting power is in error will be

$$\frac{x}{n}.$$

The angle A will be slightly in error if, when measuring, the slit on the eyepiece is not directly over the axis of rotation; this parallactic error can be rendered insensible by removing the fixed slit, behind which the observer is stationed, to a greater distance, an assistant rotating the arm. If the observer possesses a spyglass (or temporarily constructs one made of two lenses) having a wire or straight-edge placed in the field of view, more accurate and convenient measurements can be made, as both slits can then be dispensed with, the spyglass being focused on the diaphragm as seen through the eye-lens in a negative ocular or a single-lens eyepiece, and both lenses in a positive one. Moreover, the parallactic displacement of the lens due to its eccentric position as it revolves about the axis of rotation now introduces no error in the measurements, so that the telescope can be placed close to the eyepiece.

If a theodolite, having a finely-graduated horizontal circle, is available, the eyepiece can be placed over the vertical axis and the angle, measured as above, deduced from the circle readings.

It is hardly necessary to state that the diaphragm, or wires, used in determining the magnifying power, should not be at too great an angular distance from the optical axis of the eyepiece, the fixed star, used in determining the time of transit, should still be in good focus when near the edge of the field of view, and instantly occulted as it apparently touches this edge.

To find the focal constant of the eyepiece with great accuracy the distance between the stellar focus of the objective and the optical centre of the object-glass must first be determined, and probably the simplest as well as the most reliable method for finding this constant is to rule three fine straight lines upon a piece of mica plate, one of the lines being drawn at right angles to the other two; the distance D between the parallel lines subtending, at the objective, an angle of from 25′ to 50′ when placed symmetrically with respect to the optical axis in the stellar focal plane. If $\tau$ denotes the time required for the image of a star near the meridian, and having the small declination $\delta$ (viewed with a positive movable eyepiece which can be held in the hand), to pass over the linear distance D on the plate, the focal constant F of the objective will be given by the equation

$$F = \tfrac{1}{2} D \,.\, \tan \left(90^\circ - \frac{15}{2} \tau \,.\, \cos \delta\right).$$

The expression for the focal constant $f$ of the eyepiece is then :—

$$f = \frac{F}{P},$$

P being determined from the direct measurements of the angles

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subtended by any plane figure placed in the common focus of the objective and eyepiece as seen from the two ends of the telescope.

*Ann Arbor, Mich.*. 1883, *Feb.* 5.

## *Physical Observations of Jupiter.* By W. F. Denning.

Mr. Marth has discussed (*Monthly Notices*, vol. xlii. pp. 427–433) the observations of the white equatorial spot made between 1880, Aug. 27, and 1882, Aug. 7, and finds the rotation period $9^h\ 50^m\ 7^s{\cdot}42 = 878^\circ{\cdot}46$ daily rate. This is the same object as that observed by Prof. Hough (Annual Report of the Dearborn Observatory, 1882, pp. 50, 51) from 1880, Oct. 28, to 1882, March 31, and for which he has determined the period to be $9^h\ 50^m\ 9^s{\cdot}8$. The great red spot which has formed so conspicuous an object on the planet during the few preceding years has now become extremely faint, and it appears probable that it may shortly disappear. Its retarded motion continues. On 1883, Mar. 18, it crossed the planet's central meridian $1^h\ 29^m{\cdot}4$ after the assumed first meridian, as computed by Mr. Marth from the period $9^h\ 55^m\ 34^s{\cdot}47$ ($=870^\circ{\cdot}42$ daily rate). Relatively to this adopted time of rotation the spot has lost about $4^m$ per month, owing to its slackening velocity, since early in May 1881. The comparative motion of this red spot and of the white equatorial spot continue to afford some interesting results. From observations on 1883, March 15, the epoch of conjunction of the two markings was found to be, 1883, March 15, $13^h\ 38^m$. The figures show that since 1880, Nov. 19, $9^h\ 23^m$—a period of $846^d\ 4^h\ 15^m$—the white equatorial spot had completed 19 revolutions of *Jupiter* relatively to the red spot, the number of rotations performed by the latter being 2045 and by the former 2064. The white spot continues to be as brilliant and well-defined as when it first attracted notice, and gives promise to remain visible for a very lengthened period.

*Bristol*: 1883, *March.*

## *Note on Observations of Mercury.* By W. F. Denning.

I obtained observations of this planet just before sunrise on the mornings of November 6, 7, 9, and 10, 1882, with my 10-inch Browning Reflector, power about 212. Some dark, irregular spots were distinctly seen upon the planet; also a small brilliant spot, and a large white area between the E.N.E. limb and terminator. The south horn was also much blunted, especially on the two first dates of observation. My results have led me to infer that the markings upon *Mercury* are far more decided and easily discernible than those on *Venus*; and that the aspect o the former planet presents a close analogy to the physical appearance of *Mars*. The rotation period of $24^h\ 5^m\ 30^s$ given b- Schröter seemed too short to conform with the relative placy